

(12) United States Patent Silfvast et al.

(54) DISPLAY DEVICES WITH MULTIMODAL **AUDIO**

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(56)References Cited

U.S. PATENT DOCUMENTS

6/1994 Bassett et al. 5,321,416 A 5,715,321 A 2/1998 Andrea et al. (Continued)

FOREIGN PATENT DOCUMENTS

1435073 A 8/2003 5/2008 101185366 A (Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion issued in copending International Application No. PCT/US2019/032800 dated Sep. 13, 2019 (14 pp).

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(57)ABSTRACT

An audio component for a head-mounted display system includes a first port through which sound is projected to a user during operation in a first audio mode, a second port through which sound is projected to a user during operation in a second audio mode, an insulator positioned along an acoustic path between the first port and the second port, wherein the insulator is configured to inhibit sound projection along the acoustic path by isolating the first port from the second port, and an earpiece configured to engage the audio component to an ear of the a user, to deliver sound from the audio component to the user, and to reduce ambient noise from a surrounding environment during operation of the audio component in the second audio mode.

20 Claims, 18 Drawing Sheets

